[0014] FIG. **1** is a schematic cut away view of one embodiment of a gas turbine engine in accordance with the description herein;

[0015] FIG. **2** is a schematic view of one embodiment of a material in accordance with the description herein;

[0016] FIG. **3** is a schematic view of one embodiment of a material having a toughening agent applied thereto in accordance with the description herein;

[0017] FIG. **4** is a schematic view of an alternate embodiment of a material having a toughening agent applied thereto in accordance with the description herein;

[0018] FIG. **5** is a schematic view of another alternate embodiment of a material having a toughening agent applied thereto in accordance with the description herein;

[0019] FIG. **6** is a schematic perspective view of one embodiment of a fan casing preform in accordance with the description herein; and

[0020] FIG. **7** is a schematic perspective view of one embodiment of a fan casing in accordance with the description herein.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Embodiments described herein generally relate to methods for making articles having at least one toughened region and at least one untoughened region. Generally, such methods can comprise providing a material, applying a toughening agent to a portion of the material, shaping the material to produce a preform, applying an untoughened resin to the preform, and curing the preform having the applied untoughened resin wherein the toughened region corresponds to the portion of the material comprising the toughening agent. While embodiments herein may generally focus on methods for making composite fan casings for gas turbine engines, it will be understood by those skilled in the art that the description should not be limited to such. Indeed, as the following description explains, the methods described herein may be used to make any article or composite material having at least one toughened region and at least one untoughened region.

[0022] Turning to the figures, FIG. **1** is a schematic representation of one embodiment of a gas turbine engine **10** that generally includes a fan assembly **12** and a core engine **14**. Fan assembly **12** may include a fan casing **16** and an array of fan blades **18** extending radially outwardly from a rotor disc **20**. Core engine **14** may include a high-pressure compressor **22**, a combustor **24**, a high-pressure turbine **26** and a low-pressure turbine **28**. Engine **10** has an intake end **30** and an exhaust end **32**.

[0023] Initially, to make the composite materials and articles described herein, a material **38** may be provided as shown in FIG. **2**. Any traditional fabric or multiaxial non-crimp fabric capable of being combined with a resin to produce a composite material is acceptable for use herein as material **38**. In one embodiment, material **38** may be a fiber fabric selected from the group consisting of carbon fiber, glass fiber, ceramic fiber, graphite fiber, aramid fiber, and combinations thereof. As shown in FIG. **2**, material **38** may generally comprise multiple interwoven fiber tows **40**.

[0024] Once material **38** is selected, a toughening agent **42** may be applied to a portion thereof. Toughening agent **42** may comprise anything capable of providing increased toughness to the finished composite material as compared to the toughness present in the composite material without the application of a toughening agent as described herein below. In one embodiment, toughening agent **42** may be selected from the group consisting of polymers, nano fibers, nano particles, and combinations thereof, though it should not be limited to such.

[0025] Toughening agent **42** may be applied to material **38** in a variety of ways. For instance, toughening agent **42** may comprise a polymer. More specifically, in one embodiment, toughening agent **42** may comprise a polymer fiber that can be joined to the desired portion or portions of material **38** such that when an untoughened resin is later applied, as set forth herein below, a toughened resin is produced. Joining may include placing the fiber onto the material or weaving the fiber into the material (as shown in FIG. **3**) in the desired location or locations, for example. In another embodiment, toughening agent **42** may comprise a polymer powder (as shown in FIG. **4**) or polymer liquid that may be sprayed onto material **38** in the desired area or areas.

[0026] In the previously described embodiments, a toughened resin can be produced when an untoughened resin is later applied. The toughened resin can generally correspond to the portion or portions of the material comprising the polymer toughening agent. As used herein, "toughened resin" refers to resin that, when cured, displays a fracture toughness, or K_{1C} (i.e. the material's resistance to fracture when a crack is already present), of at least about 1.0 MPa-$m^{1/2}$.

[0027] Alternately, as shown in FIG. **5**, toughening agent **42** may comprise nano fibers such as nano carbon fibers, nano particles such as nano clay particles, and combinations thereof. Such toughening agents can be combined with an untoughened resin **43** gel, powder, or liquid, to make a toughened resin **44**. Toughened resin **44** may then be applied to the desired portion or portions of material **38**. As used herein "untoughened resin" refers to resin that, when cured, displays a fracture toughness, or K_{1C}, of less than about 1.0 MPa-$m^{1/2}$. It is the addition of the toughening agent to the untoughened resin that, when cured, provides the toughened resin as defined herein. While the ratio of nano fibers/particles to resin may vary, in one embodiment the nano fibers/particles may account for from about 5% to about 20% by weight of the toughened resin, with the untoughened resin accounting for from about 80% to about 95% by weight.

[0028] In general, untoughened resin, when cured, can produce an untoughened region while toughened resin, when cured, can produce a toughened region, as defined herein below. While not intending to be limited by theory, it is believed that in the context of polymer toughening agents (whether fibers, powders, liquids or some combination thereof), when the untoughened resin is applied to the preform having the applied toughening agent, the untoughened resin can react with the previously applied polymer toughening agent to provide added fracture resistance to the cured composite material in the area generally corresponding to the portion of the material comprising the toughening agent. When using nano fibers/particles, it is believed that such toughening agents can enrich the resin and provide for a toughened region in the composite material after curing.

[0029] Material **38** may be shaped to produce a preform of a desired article, which in one embodiment may comprise a fan casing preform **45**. As shown in FIG. **6**, fan casing preform **45** may comprise a body **47** having any form desired and may be fabricated using any tool known to those skilled in the art. See, for example, U.S. Patent Application No. 2006/0134251 to Blanton et al. While embodiments set forth herein generally describe application of the toughening agent followed by shaping of the material into a preform, those skilled